forest management note

Note 47 Northwest Region

SITE PREPARATION AFFECTS WHITE SPRUCE SEEDLING PERFORMANCE AFTER 20 YEARS

Planting in the rough without site preparation has been correlated with poor seedling performance in operational plantations in the prairie provinces; the consequences are usually dense vegetative competition with associated high mortality (Froning 1972). Before herbicides became registered for vegetation control in forest plantations, summer "straight-blading" was often the prescribed site treatment for both research and operational planting in the Mixedwood Section (B.18a) of the Boreal Forest Region (Rowe 1972). The "scalping" treatment, which was intended to get sufficiently deep to take out the roots of aspen (*Populus tremuloides* Michx.) and other perennating vegetation, was usually fairly severe.

Earlier trials in 1952 in Manitoba in Riding Mountain National Park on moderately well drained Orthic Gray Luvisols showed that early survival and growth of white spruce (*Picea glauca* (Moench) Voss) could be improved by blading to mineral soil and disking with an Athens plow (Waldron 1964). The overall height at 10 years, however, was not related to the preplanting site preparation.

Further study was initiated in 1962 in the same general area with the establishment of three trials[1] to examine the effects of blading and cultivating prior to planting on the survival and growth of white spruce transplants. It was suspected that the physical nature of the B horizon of the heavy clay loam tills impeded root development and that cultivation would increase the height growth of white spruce transplants. This note discusses the results of the latest remeasurement 21–23 years after planting.

METHODS

The study consisted of three trials of 10 blocks each: the first was prepared in 1962 and planted in 1963; the second was prepared in 1963 and planted in 1964; and the third was prepared in 1964 and planted in 1965. Using a split-plot design, each 12.2 × 12.2-m block was divided in half. The randomized main plot treatments were bladed (summer bulldozer scarification in 4.9-m-wide strips) and nonbladed. One-half of each main plot was subdivided at random into spaded (soil turned over manually with a shovel) subplots, resulting in the following site preparation treatments (Fig. 1):

1) nonbladed (planting in the rough),
2) nonbladed and spaded (planting in an inverted A horizon),
3) bladed (planting in the B horizon), and
4) bladed and spaded (planting in a partially inverted B horizon).

Nine seedlings were spring planted in each plot at 1.2-m spacing. Uniformly graded 2+2 transplant stock from the provincial tree nursery at Hadashville was used each year. Following planting, the areas were fenced. On the undisturbed plots and on a 1.2-m strip surrounding

[1] Jarvis, J.M. 1963. The effect of scalping and cultivating (prior to planting) on the survival and growth of white spruce, mesic clay loams, Riding Mountain Forest Experimental Area. Can. Dep. For., For. Res. Lab., Winnipeg, Manitoba. Progress report 63-MS-4.

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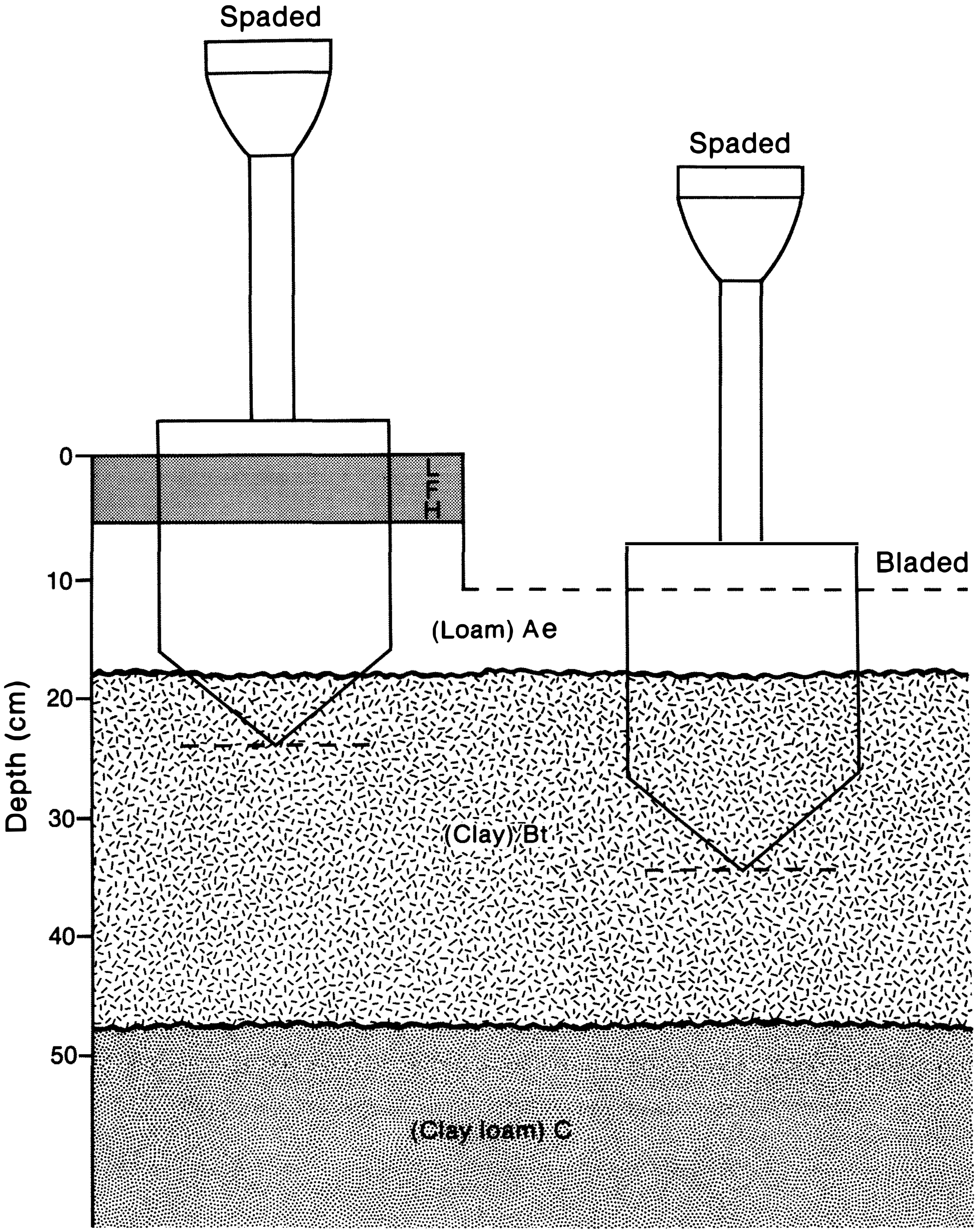

Figure 1. Site preparation treatments.

each block, shrubs such as hazel (*Corylus cornuta* Marsh.) were cut and removed[2]. Seedlings that died in 1963 and 1964 were replaced in 1965. Vegetation was mowed on all plots in 1969, and fences were removed shortly after 1970. Height growth and mortality were measured annually until 1969 and thereafter in 1973, 1981, and 1986.

All growth calculations were based on data from the original, unreplaced seedlings. For each replication of 10 blocks, treatment means of diameter, height, and leader growth were calculated for the various remeasurements using split-plot analysis methods (Jeffers 1960). Mortality rates were compared using chi-square analysis.

RESULTS AND DISCUSSION

Results from all three replications show that summer blading significantly improved long-term survival of white spruce transplants (Table 1) but had a profound, lasting, and negative impact on diameter, total height, and height increment (Table 2). The spading treatment, which did not affect growth, improved survival on nonbladed plots on two of the three trials.

Mortality was highest (Table 1) on the first trial area, where beaver (*Castor canadensis* Kuhl) caused some seasonal flooding on bladed plots. Judging from the flooding that occurred on the first-year replication as well as the sparseness of vegetation today, it is suspected that the blading was more severe on the first-year trial than on the last two trials. Survival was also likely influenced favorably by the fence that prevented browsing. The vegetation management that was carried out during the first 5-year establishment period could also have obscured anticipated survival advantages of seedlings on bladed seedbeds over those planted in the rough. In later years, between 1965 and 1986, mortality increased at a significantly greater rate on nonbladed treatments on all replications (Table 1).

Blading effects were most pronounced in terms of diameter growth. Diameters on nonbladed plots were, on average, 60% greater than those on bladed plots (Table 2). Total height after 21-23 growing seasons averaged over 1 m, or about one-third, more on nonbladed plots (Fig. 2). Annual height increment was significantly greater on nonbladed plots in all replications both after 8-10 and 21-23 growing seasons (Fig. 3), indicating that differences in total height between blading and nonblading are still increasing.

CONCLUSIONS

The practice of blading substantial portions of cutover areas for landings in standard tree-length logging operations may have long-lasting and deleterious growth consequences for planted white spruce. Blading exposes soil horizons with high bulk density, which results in decreased seedling growth (Corns 1988). It follows that the same effects on survival and growth would influence stocking and growth of established white spruce on seeded areas. Such operational blading, particularly in low areas, can also lower site productivity by creating minor depressions that are prone to flooding.

The small positive effects of spading on growth of white spruce transplants after 8-10 growing seasons (Steneker 1975) have disappeared; half of the values of the spaded plots after 21-23 growing seasons were less than those that were not spaded (Table 2).

These results show that blading assists survival through long-term vegetation control; however, the substantial difference in growth two decades later suggests that alternative site treatments such as winter blading may be desirable. This treatment, which leaves the duff and fertile upper soil horizons, would improve seedling growth (McMinn 1982). Survival could be improved by reducing competition with careful application of herbicides such as glyphosate before or after planting.

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Table 1. Mortality of white spruce seedlings after 21-23 growing seasons on three trials

Trial	Main plot treatment	Subplot treatment	Mortality (%)[a] Before 1965	1965-86	All
Trial 1 (1963)	Nonbladed	Nonspaded	4.4	10.0	14.4
		Spaded	3.3	17.8	21.1
	Bladed	Nonspaded	32.2	4.4	36.6
		Spaded	23.3	5.6	28.9
	Total nonbladed		3.9	13.9	17.8
	Total bladed		27.8 ***	5.0 **	32.8 ***
Trial 2 (1964)	Nonbladed	Nonspaded	4.4	35.6	40.0
		Spaded	1.1	10.0 ***	11.1 ***
	Bladed	Nonspaded	5.6	12.2	17.8
		Spaded	3.3	12.2	15.6
	Total nonbladed		2.8	22.8	25.6
	Total bladed		4.4	12.2 **	16.7 *
Trial 3 (1965)	Nonbladed	Nonspaded	—[b]	15.7	15.7
		Spaded	—	5.6 *	5.6 *
	Bladed	Nonspaded	—	2.2	2.2
		Spaded	—	0.0	0.0
	Total nonbladed		—	10.7	10.7
	Total bladed		—	1.1 ***	1.1 ***

a * Differs from value in row immediately above; p = 0.05.
** Differs from value in row immediately above; p = 0.01.
*** Differs from value in row immediately above; p = 0.001.
b Not applicable.

Table 2. Diameter, height, and height increment of white spruce after 21-23 growing seasons for all three trials

Main plot and subplot treatment	Diameter (cm) 21 yr	22 yr	23 yr	Height (cm) 21 yr	22 yr	23 yr	4-year height increment (cm) 17-21 yr	18-22 yr	19-23 yr
Nonbladed									
Nonspaded	6.6 (0.3)[a]	7.0 (0.2)	8.7 (0.2)	431 (14)	406 (9)	466 (12)	133 (4)	133 (7)	140 (12)
Spaded	7.2 (0.2)	6.7 (0.3)	7.0 (0.3)	459 (14)	400 (14)	428 (16)	124 (6)	131 (7)	130 (11)
Bladed									
Nonspaded	4.0 (0.3)	3.6 (0.6)	5.8 (0.7)	322 (16)	275 (26)	336 (33)	109 (7)	97 (9)	119 (11)
Spaded	4.8 (0.5)	3.9 (0.5)	5.0 (0.7)	349 (23)	293 (27)	338 (32)	105 (10)	107 (8)	101 (15)
Total									
Nonbladed	6.9 (0.2)	6.9 (0.2)	7.9 (0.3)	445 (10)	403 (8)	448 (11)	129 (4)	132 (5)	135 (8)
Bladed	4.4 (0.3)	3.7 (0.4)	5.4 (0.5)	335 (15)	284 (19)	337 (23)	107 (6)	102 (6)	110 (10)
All	5.6 (0.3)	5.3 (0.3)	6.6 (0.3)	390 (12)	344 (14)	391 (16)	118 (4)	117 (5)	123 (7)

a Standard error in brackets.

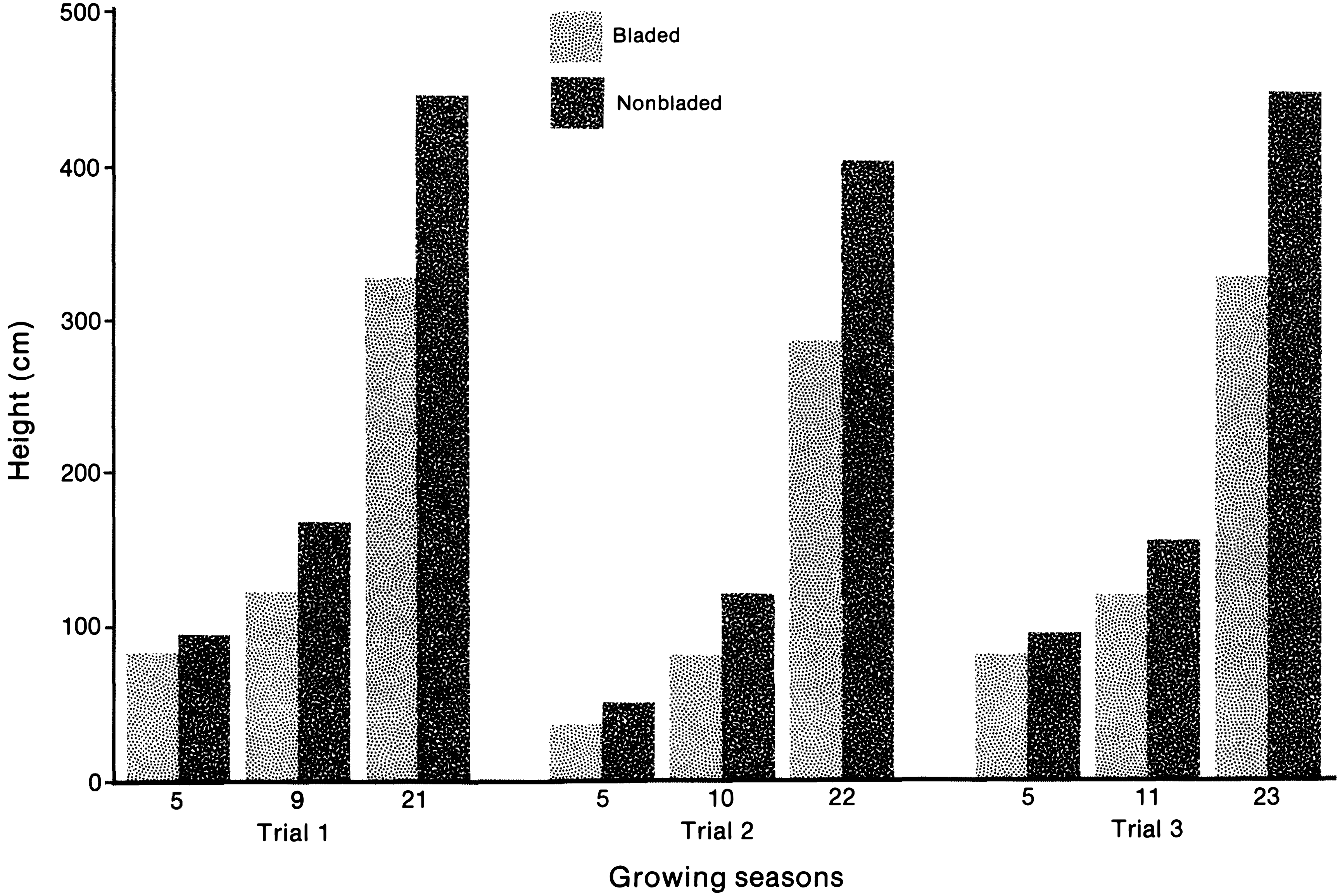

Figure 2. Mean seedling height by age for all three trials.

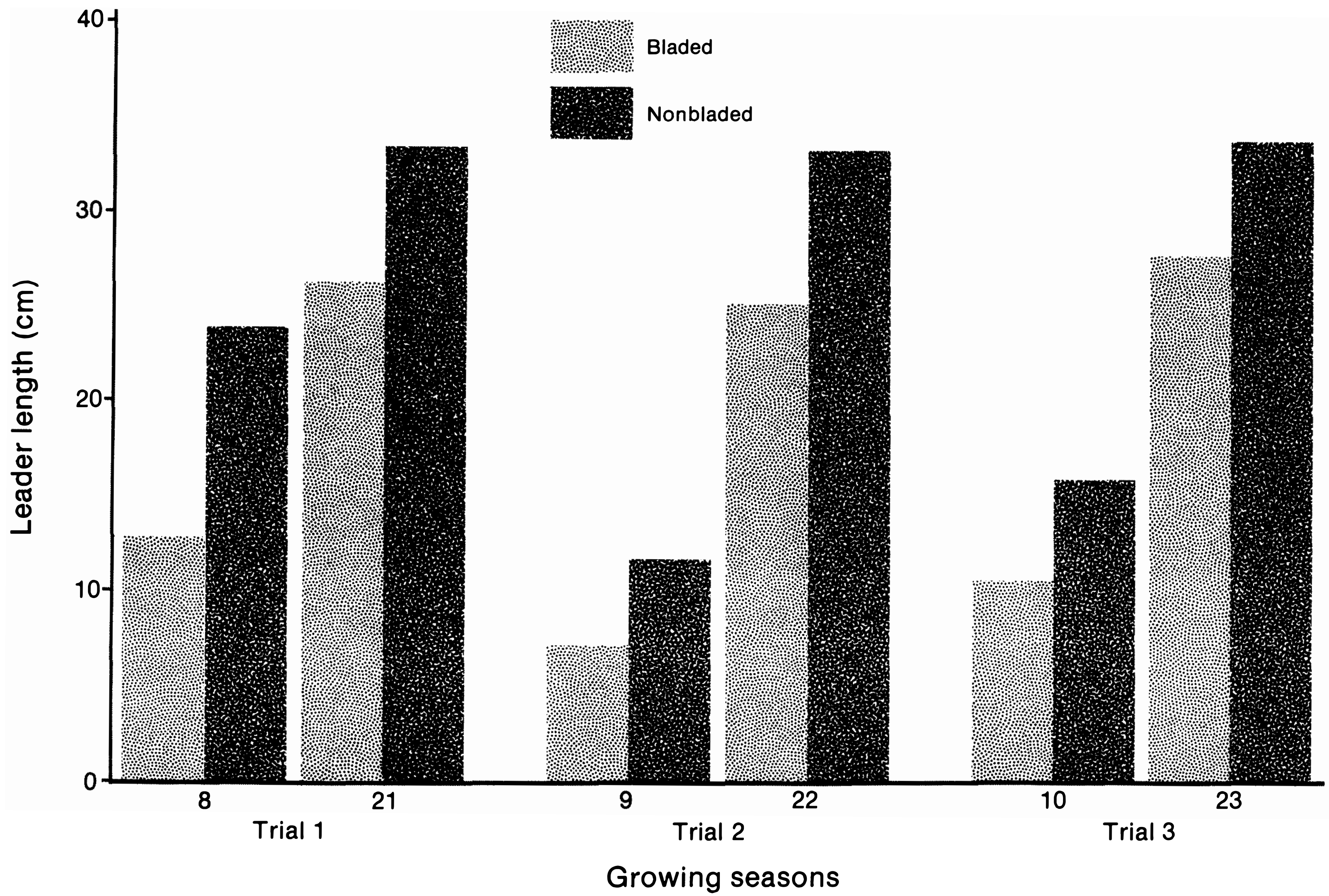

Figure 3. Mean annual height increment by age for all three trials.

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